



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N3

30 July 2025

This marking guideline consists of 10 pages.

SECTION A

QUESTION 1

1.1	1.1.1	D✓	(5 × 1)	(5)
	1.1.2	C✓		
	1.1.3	B✓		
	1.1.4	B✓		
	1.1.5	B✓		
1.2	1.2.1	True✓	(5 × 1)	(5)
	1.2.2	False✓		
	1.2.3	True✓		
	1.2.4	True✓		
	1.2.5	True✓		
1.3	1.3.1	C✓	(5 × 1)	(5)
	1.3.2	A✓		
	1.3.3	J✓		
	1.3.4	B✓		
	1.3.5	D ✓		
1.4	1.4.1	Resolution✓	(5 × 1)	(5)
	1.4.2	Systematic errors✓		
	1.4.3	Wheatstone bridge ✓		
	1.4.4	Dual beam✓		
	1.4.5	Photovoltaic cell ✓		
				[20]
TOTAL SECTION A:				20

SECTION B

QUESTION 2: DC THEORY AND AC THEORY

- 2.1 2.1.1 **LOOP 1 (ABCEFA):**
 $V_T = V_{R2} + V_{R4}$
 $V_T = (I_1 - 0,6).R_2 + I_2.R_4$
 $12 = 15.I_1 - 15(0,6) + 22I_2 \quad \checkmark$
 $3 = 15.I_1 + 22I_2 \quad \text{_____}(1) \quad \checkmark \quad (2)$
- 2.1.2 **LOOP 2 (BDCB):**
 $V_T = V_{R1} - V_{R3} - V_{R2}$
 $0 = 0,6R_1 - (I_1 - I_2 - 0,6).R_3 - (I_1 - 0,6).R_2 \quad \checkmark$
 $0 = 20.0,6 - 15I_1 + 15I_2 + 15.0,6 - 15I_1 + 15.0,6$
 $30 = 30I_1 - 15I_2 \quad \text{_____}(2) \quad \checkmark \quad (2)$
- 2.1.3 (1) $\times -2$:
 $3(-2) = 15(-2)I_1 + 22(-2)I_2 \quad \text{_____}(1)$
 $-6 = -30I_1 - 44I_2 \quad \text{_____}(3) \quad \checkmark$

 $(2) + (3)$
 $30 = 30I_1 - 15I_2 \quad \text{_____}(2)$
 $-6 = -30I_1 - 44I_2 \quad \text{_____}(3)$
 $\underline{24 = -59I_2}$
 $I_2 = -0.407A$
 $I_2 = 0.407A \quad \checkmark$

 Replace I_2 in (1):
 $3 = 15I_1 + 22I_2 \quad \text{_____}(1)$
 $3 = 15I_1 + 22(0.407) \quad \checkmark$
 $3 = 15I_1 + 8.954$
 $15I_1 = -5.954$
 $I_1 = -0.397$
 $I_1 = 0.397A \quad \checkmark \quad (4)$

$$2.2 \quad 2.2.1 \quad X_L = 2\pi fL$$

$$X_L = 2\pi \cdot 50 \cdot 150 \times 10^{-3}$$

$$\underline{X_L = 47,124\Omega} \quad \checkmark$$

$$Z_{RL} = \sqrt{R^2 + X_L^2}$$

$$Z_{RL} = \sqrt{75^2 + 47,124^2}$$

$$\underline{Z_{RL} = 88,578\Omega} \quad \checkmark$$

$$I_{RL} = \frac{V}{Z_{RL}}$$

$$I_{RL} = \frac{210}{88,578} \quad \checkmark$$

$$\underline{I_{RL} = 2,371A} \quad \checkmark$$

(4)

$$2.2.2 \quad \cos \theta_L = \frac{R}{Z_{RL}}$$

$$\cos \theta_L = \frac{75}{88,578} \quad \checkmark$$

$$\theta_L = \cos^{-1} \frac{75}{88,578}$$

$$\underline{\theta_L = 32,144^\circ} \quad \checkmark$$

(2)

$$2.2.3 \quad X_C = \frac{1}{2\pi fC}$$

$$X_C = \frac{1}{2\pi \cdot 50 \cdot 100 \times 10^{-6}}$$

$$\underline{X_C = 31,831\Omega} \quad \checkmark$$

$$I_C = \frac{V}{X_C}$$

$$I_C = \frac{210}{31,831}$$

$$\underline{I_C = 6,579A}$$

(2)

$$2.2.4 \quad I_{HC} = 0 + I_{RL} \cos \theta_L$$

$$I_{HC} = 0 + 2,371 \cdot \cos(32,144)$$

$$I_{HC} = 2,008 A \quad \checkmark$$

$$I_{VC} = I_C \sin \theta_C - I_{RL} \sin \theta_L$$

$$I_{VC} = 6,579 \sin 90 - 2,371 \cdot \sin(32,144)$$

$$I_{VC} = 5,318 A \quad \checkmark$$

$$I_T = \sqrt{I_{HC}^2 + I_{VC}^2}$$

$$I_T = \sqrt{2,008^2 + 5,318^2}$$

$$I_T = 5,684 A \quad \checkmark$$

$$\theta_T = \cos^{-1} \left(\frac{I_{HC}}{I_T} \right)$$

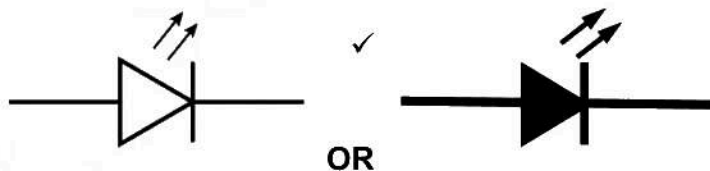
$$\theta_T = \cos^{-1} \left(\frac{2,008}{5,684} \right)$$

$$\theta_T = 67,816^\circ \quad \checkmark$$

(4)
[20]

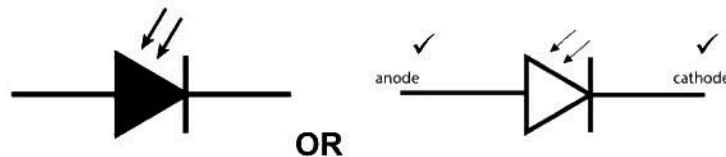
QUESTION 3: SEMI-CONDUCTOR DIODES AND TRANSDUCERS

3.1 3.1.1



(1)

3.1.2



(2)

3.2 The operation of a photodiode is achieved through the process of absorbing light and converting the changes in light into changes in reverse current. ✓

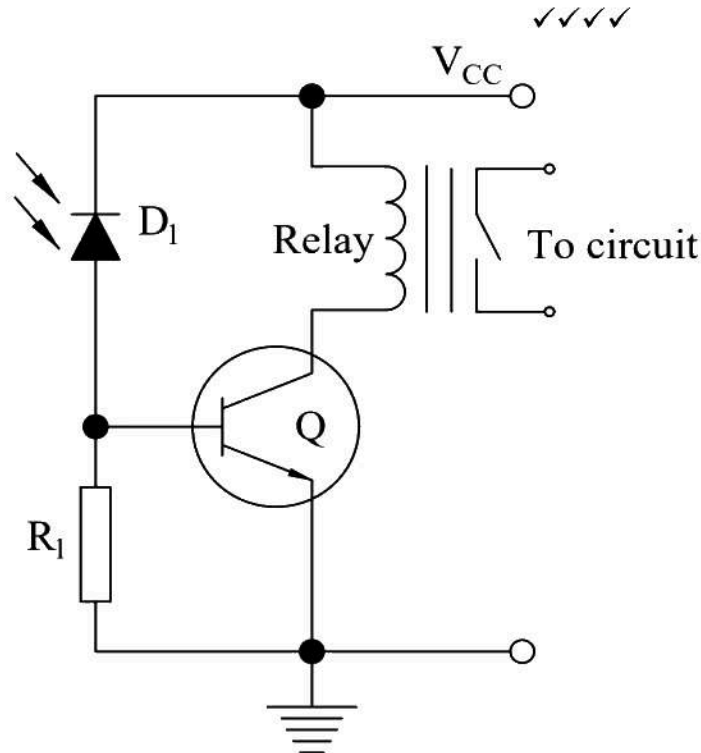
(2)

OR

A photodiode's principle of operation is based on the photoelectric effect: when light photons with sufficient energy strike the device, they generate electron-hole pairs, which then move under the influence of an electric field, creating an electrical current. This current is proportional to the intensity of the incident light.

(Marker to use discretion)

3.3



(1 mark for each correct symbol)

(4)

3.4

- 3.4.1 pentavalent✓
- 3.4.2 trivalent✓
- 3.4.3 N-type✓
- 3.4.4 P-type✓
- 3.4.5 Electron✓
- 3.4.6 holes✓

(6 × 1)

(6)

3.5

- 3.5.1 Strain gauge.✓

(1)

- 3.5.2 It operates on the principle of the piezoresistive effect, where the electrical resistance of a material changes✓ when it is subjected to mechanical strain.✓

OR

When a certain force is applied to a metal to make it expand or contract, the electrical resistance changes accordingly.

(2)

3.5.3

- Force** – aircraft wings, concrete pylons,✓
- Displacement** – Bridges, buildings✓
- Torque** – motor, turbine, or engine to fans, generators, wheels, or propellers.
- Structural Analysis** – train tracks – axial tension or compression

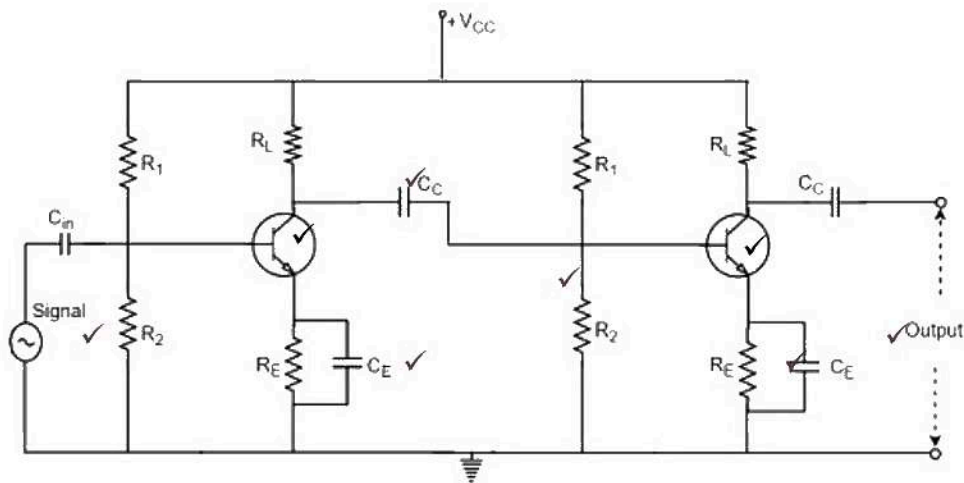
(ANY TWO CORRECT ANSWERS)

(2)

[20]

QUESTION 4: SEMI-CONDUCTOR TRANSISTORS AND OPERATIONAL AMPLIFIERS

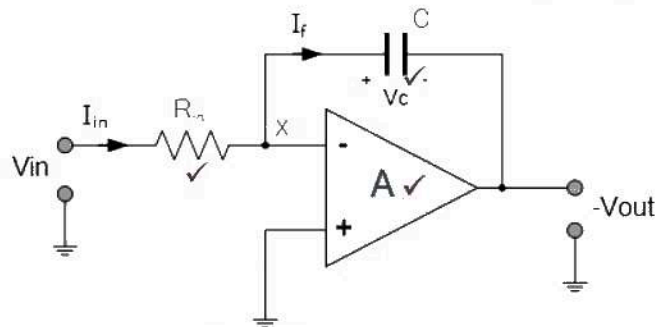
4.1



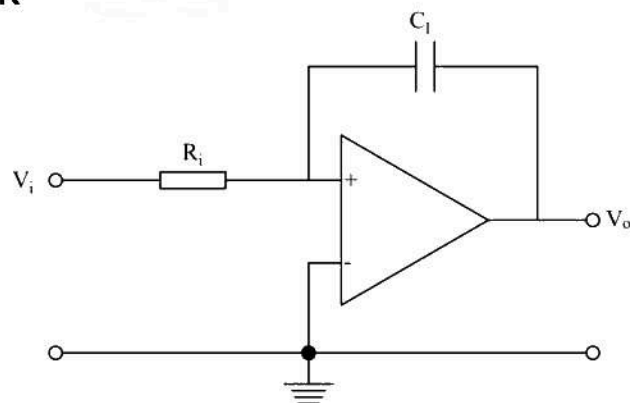
(Marker to use discretion) (6)

4.2

4.2.1

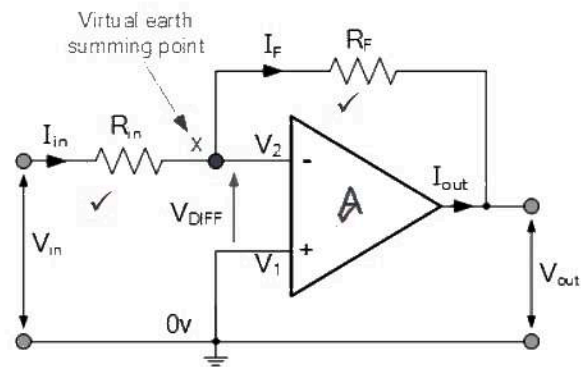


OR



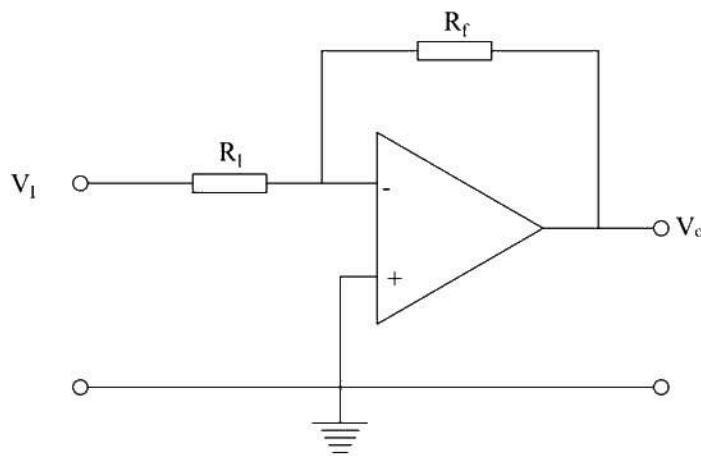
(3)

4.2.2



(3)

OR



4.3

- High open-loop gain, ✓
- High input impedance, ✓
- Low output impedance, ✓
- High common-mode rejection ratio (CMRR), ✓
- High bandwidth,

(ANY FOUR CORRECT ANSWERS)

(4)

4.4

- 4.4.1 current ✓
- 4.4.2 voltage ✓
- 4.4.3 unipolar ✓
- 4.4.4 one ✓

(4 × 1)

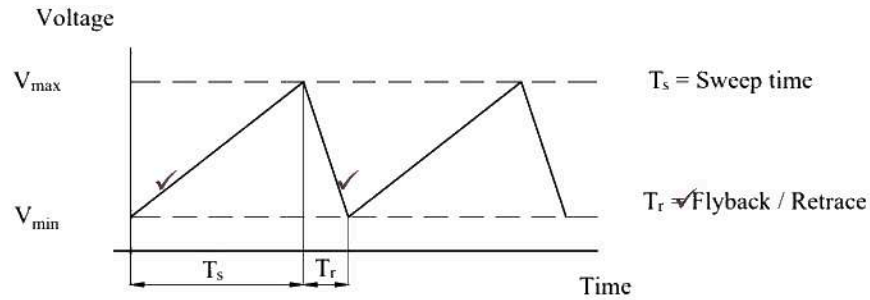
(4)

[20]

QUESTION 5: MEASURING INSTRUMENTS AND ELECTRONIC POWER CONTROL

5.1

5.1.1



(4)

5.1.2

During the "sweep time," which is the rising edge of the sawtooth waveform, the electron beam moves steadily from left to right across the screen, allowing the input signal to be displayed as a function of time.✓✓

(2)

5.2

5.2.1

SCRs are "latching" devices, meaning they turn on and stay on once triggered until their forward current is reduced to zero. To control the flow of power or turn the SCR off, we need a way to interrupt this conduction.✓✓

(2)

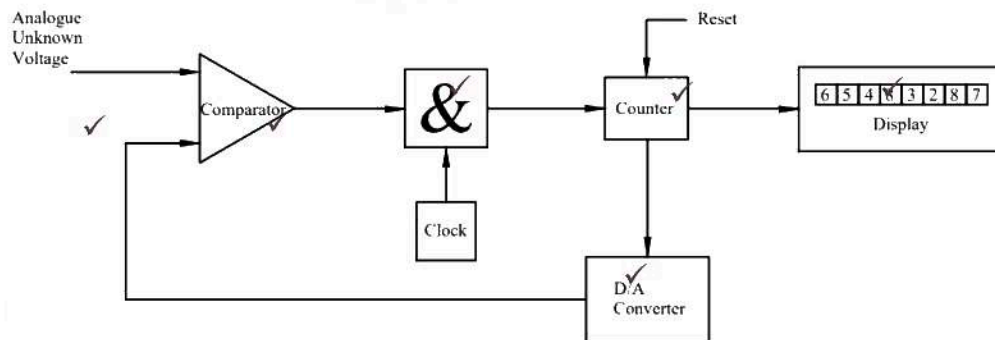
5.2.2

- Forced commutation✓
- Line/Natural commutation✓

(ANY TWO CORRECT ANSWERS)

(2)

5.3



(Marker to use discretion)

(6)

5.4

- Gate triggering,✓
- Forward voltage triggering,✓
- Temperature triggering

(ANY TWO CORRECT ANSWERS)

(2)

- 5.5 In an oscilloscope, deflection plates are used to steer the electron beam within the cathode ray tube (CRT), enabling the display of voltage waveforms on the screen. They are essentially electrostatic deflectors that move the beam either vertically or horizontally,✓ allowing for the visualization of the input signal's amplitude (vertical deflection) and time-based sweep (horizontal deflection).✓

(Marker to use discretion)

(2)

[20]

TOTAL SECTION B:

80

GRAND TOTAL:

100